MULTIMEDIA UNIVERSITY

STUDENT ID NO

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 2, 2018/2019**

## EEM1026 – ENGINEERING MATHEMATICS II

(ME/ TE/ RE)

6 MARCH 2019

9:00 a.m. – 11:00 a.m.

(2 Hours)

---

**INSTRUCTIONS TO STUDENTS:**

1. This exam paper consists of 4 **pages** (including cover page) with 4 Questions only.
2. Attempt all the questions. All questions carry equal marks and the distribution of marks for each question is given.
3. Please write all your answers in the Answer Booklet provided. Show all relevant steps to obtain maximum marks.

## Question 1

(a) By using the method of undetermined coefficients, solve the following inhomogeneous differential equation.

$$y'' + 3y' + 2y = 3\cos 2x + 4e^{2x}$$

[12 marks]

(b) Consider the solution of $\frac{dy}{dx} + (4x - 3)y = 0$ in the form of power series in $x$ about $x_0 = 0$, i.e., $y = \sum_{n=0}^{\infty} c_n x^n$. Find the first five nonzero terms of this series solution. [13 marks]

## Question 2

(a) A random sample of 64 motorists spent an average of 5.2 minutes with a standard deviation of 1.5 minutes to refill their fuel tank at BBP gasoline station.

(i) Find a **99% confidence interval** for the mean time taken to refill fuel tank. [8 marks]

(ii) The result of the study is reported to Mr. Kenji, the manager of gasoline station. While waiting in line to refill fuel, a motorist asks Mr. Kenji the amount of time he needs to wait for his turn. Based on the result in (i), what is the best answer he could give to the motorist? [2 marks]

(b) Harmonic Corporation produces smartphone speaker components. The company claims that the average weight of its *SPK* model components is 15 grams. A market researcher picked a random sample of 20 *SPK* model components to check the claim. It is found that the average weight of these 20 components is 15.1 grams with a standard deviation of 0.2 gram. At significance level of 0.02, does the claim made by Harmonic Corporation hold true? Briefly explain your answer. [9 marks]

(c) A random sample of 5 table tennis balls is selected and the diameter (in mm) of each table tennis ball is:

39.80 40.00 40.00 40.01 40.04

(i) Find the point estimate of mean. [2 marks]

(ii) Find the point estimate of variance. [4 marks]

**Continued...**

**Question 3**

Consider a rectangular bar of length $L$ where heat can only flow **along** its length (the $y$-axis). The end of the bar at $y = 0$ is held at zero temperature and the end at $y = L$ is insulated. The temperature distribution is governed by the heat equation given by the boundary value problem as follows:

$$\text{PDE}: u_t = k^2 u_{yy} \text{ for } 0 < y < L, t > 0$$
$$\text{BCs}: u(0,t) = 0, u_y(L,t) = 0 \text{ for } t > 0$$

By using method of separation of variables where $u(y,t) = F(y)G(t)$ and $\lambda$ is the separation constant:

(a) Show that $F'' = \lambda F$ , $G' = \lambda k^2 G$ with conditions $F(0) = 0$ and $F'(L) = 0$.

[8 marks]

(b) Hence, find the normal modes of temperature distribution $u(y,t)$. [15 marks]

[Hint: You are to consider only the case where $\lambda < 0$.]

(c) Rewrite the boundary conditions (BCs) if both ends of the bar are insulated.

[2 marks]

**Question 4**

(a) Solve the following initial-value problem by Laplace transform.

$$y'' + 3y' = \sinh t, \quad y(0) = 0 \text{ and } y'(0) = 1.$$ [13 marks]

(b) Find the Fourier transform of

$$f(t) = \begin{cases} 2, & -2 \le t \le 0 \\ 2, & 0 \le t \le 2 \\ 0, & \textit{otherwise.} \end{cases}$$ [12 marks]

[Hint: Formula of Fourier transform is $F(w) = F\{f(t)\} = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(t) e^{-i\omega t} dt$]

**Continued...**

# *APPENDIX*

## Table : Laplace transform for some of function $f(t)$

| $f(t)$ | $F(s) = \mathcal{L}\{f(t)\}$ |
|---|---|
| 1 | $1/s$ |
| $t$ | $1/s^2$ |
| $t^n (n = 1, 2, 3, \ldots)$ | $n!/s^{n+1}$ |
| $e^{at}$ | $\frac{1}{s-a}$ |
| $te^{at}$ | $\frac{1}{(s-a)^2}$ |
| $t^{n-1}e^{at}$ | $\frac{(n-1)!}{(s-a)^n}, n = 1,2,\ldots\ldots$ |
| $\cos at$ | $\frac{s}{s^2+a^2}$ |
| $\sin at$ | $\frac{a}{s^2+a^2}$ |
| $\cosh at$ | $\frac{s}{s^2-a^2}$ |
| $\sinh at$ | $\frac{a}{s^2-a^2}$ |
| $u(t-a)$ | $\frac{e^{-as}}{s}, a \geq 0$ |
| $f(t-a)\,u(t-a)$ | $e^{-as}L(f)$ |
| $f(t)\,\delta(t-a)$ | $e^{-as}f(a)$ |
| $f'(t)$ | $sL(f) - f(0)$ |
| $f''(t)$ | $s^2L(f) - sf(0) - f'(0)$ |

**End of paper.**